SUBURBAN GARDENS IN SOUTH-WEST LONDON AS HOMES FOR SUBTERRANEAN BEETLES

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IN THE SPRING of 1995, the trial of a prototype underground pitfall-trap in the author's garden revealed that it was providing a home for the subterranean weevil *Raymondionymus marqueti* (Aubé) and a number of other soil-inhabiting beetle species (Owen, 1995). To find out more about the subterranean beetle fauna of gardens in the area, underground pitfall-traps were set in a number of suburban gardens in south-west London.

The survey

The study was carried out during 1995, 1996 and 1997. Traps were set in gardens usually in a border near the perimeter fence in soil containing roots of trees or shrubs. Mostly, only one trap was set in each garden but two were set in one garden and three in another. A few traps were set in the middle of grass lawns. All the gardens lay within a circle of radius 15km from the centre of Epsom, Surrey. In preliminary studies, traps were set in a few gardens for two or three weeks only but, to allow reasonable comparison between gardens, only data from gardens in which traps were for at least 12 weeks sometime in the period May to August are considered in this paper. Four of the gardens had been created on chalk (rendzina), one on fine sand, five on loam and two on clay.

The pitfall-traps were set and operated as previously described (Owen, 1997a), with the minor change of having an empty plastic drinking container pushed into the top of the mesh cylinder to make the trap more secure against the entry of surface fauna. They were charged with a mixture of equal parts malt vinegar and sweet sherry. The contents of traps were examined at intervals of two to eight weeks and all the beetles present identified and counted. Because more than one trap was set in some gardens, trapping effort at each garden was computed in terms of trap-weeks. The total trapping effort expended was 496 trap weeks.

Results

The 2240 beetles collected comprised 60 species. A list of these is given in Table 1, which indicates the number of gardens in which each species was found and the numbers of each species trapped. The relative abundances of species varied considerably. A few species were found in some numbers but no fewer than 20 species (33% of the total) were represented by single specimens. No species was trapped in all 12 gardens but *Raymondionymus marqueti* was trapped in 10 gardens and two others – *Rhizophagus perforatus* and *Anommatus duodecimstriatus* were trapped in nine gardens.

Four of the species trapped are Red Data Book species (Hyman and Parsons, 1992; 1994) *viz Alevonota aurantiaca* (RDB1), *Trichonyx sulcicollis* (RDB2),

Anommatus diecki (RDBK) and *Langelandia anophthalma* (RDB3) and three are Nationally Notable *viz.* – *Acrotona parens, Athous campyloides* and *Anommatus duodecimstriatus*.

The influence of soil type on the catch is summarised in Table 2. On average, gardens on chalk produced the largest catch (expressed as beetles per trap-week) whereas gardens on clay, produced on average, the largest number of species. Traps set in the middle of grass lawns failed to catch any beetles.

Discussion

The fact that gardens can possess an extensive beetle fauna is well documented. Henderson (1945, 1946) recorded 366 species from his garden at Purley, Surrey. Allen (1998) recorded 805 species from his garden at Blackheath, Kent during the years 1927 – 1973. Neither of these authors specifically sought subterranean species but findings in this study indicate that gardens are rich in these species too. No doubt, a longer list of garden subterranean species could have been obtained by further effort but there would undoubtedly be a diminishing return. Not one of the species was found in all 12 gardens. Most of the species encountered were trapped in less than half of the gardens studied but it has to be noted that, when traps were set in more than one position in a garden, the catch in terms of species present varied in different positions. Thus the apparent absence of a species from a garden may have been more due to the position(s) selected for the trap(s) rather than to a real absence. Not surprisingly, most of the beetles species trapped underground are small. In this study, 95% of the specimens belonged to species less than 5mm long and easily able to pass through a tunnel 1 sq mm in cross section.

Many of the species trapped are recognised as species normally living or developing in the soil. Others live on the surface of the soil or in decaying vegetation and may have found their way into traps by chance, perhaps burrowing into the soil to escape desiccation. Some, such as *Carpophilus marginellus* and *Glischrochilus hortensis*, are normally associated with sap running from tree wounds or under bark and may have been attracted to the traps by the sherry-vinegar mixture with which they were baited. *Abraeus globosus* normally occurs in rotten wood and it may be relevant that there were rotten logs lying on the soil near where the particular trap was set.

There was considerable variation in the relative abundances of different species. This is the usual finding in surveys by trapping (see, for example, Williams, 1964; Taylor, 1978). The abundances of 499 species recorded by trapping with a flight-interception trap ranged from one to 841 specimens (Owen, 1993); 125 species (27% of the total) were represented by single specimens.

There does not appear to have been published a list of subterranean beetles with which this garden list can be compared but an on-going similar survey of subterranean beetles in woodlands in the same general area has produced to-date 100 species. Some of these have occurred both in gardens and woodlands but there are apparently differences in the subterranean beetle fauna in the two habitats. Thus out

of the 60 species trapped in gardens, 36 have not so far been trapped in woodlands. Of the seven Red Data Book and Nationally Notable species found in gardens, only one - *Anommatus duodecimstriatus* – has turned up in woodlands. A full comparison of gardens and woodlands obviously requires more woodland trapping but it is unlikely that all the differences already noted will disappear.

The paucity of species and beetles in the one garden on fine sand is mirrored by a similar paucity in woodland on the same type of soil. Fine sand naturally packs tightly making it difficult for beetles to pass through it. Holes made by the passage of worms and other tunnelling creatures are not semi-permanent in sand as they are in the other types of soil. The greater number of species from gardens on clay may be related to the moisture holding properties of this type of soil.

Five of the species trapped in gardens, *viz.*–, *P. wollastoni, A. diecki, A. duodecimstriatus L. anophthalma* and *R. marqueti* have an number of features in common. They lack eyes and wings and except, for *P. wollastoni*, have fused elytra. Apart from *A. diecki*, they were among the beetles trapped in greatest numbers in gardens. Three of these species – *A. diecki, L. anophthalma* and *R. marqueti*, have not so far turned up in traps in woodland while the other two turned up there in very small numbers – two and ten respectively. It thus seems that lack of eyes and wings and fused elytra are features specialised for an underground lifestyle and that in south-east England, at least, the more specialised underground beetles are insects of gardens rather than insects of the countryside. Absence of wings must seriously interfere with natural spread of an insect and it may be that these beetles were introduced to Britain and distributed between gardens by human activities.

The presence of a number of Red Data Book and Nationally Notable species in gardens raises an interesting conservation issue. The national status of insects is one of the factors used in deciding which habitats should receive priority in protection and it would seem sensible that the importance of this index should not be weakened by giving high status to more or less exclusively garden insects. The same argument applies to species living in man-made compost heaps. One grass-compost heap studied over a three year period was found to harbour six Red Data Book and eight Nationally Notable species, some of which appear to be more or less confined to this habitat (Owen, Allen, Booth & Luff, 1997).

Notes on selected species

Stomis pumicatus. This was the only carabid to be trapped more than once. Little appears to be known about it ecology but its recorded occurrence in flood debris is consistent with a subterranean life style. The elongate mandibles could conceivably be an adaptation to seeking prey in tunnels in the soil.

Parabathyscia wollastoni. This beetle was the most abundant of the species trapped in gardens comprising over a third of the total specimens. Though it was recorded from four gardens, 917 specimens came from a single trap in a garden on chalk. In gardens, it occurs nearly entirely underground; it was not among the 366 species recorded in his garden by Henderson (1945, 1946) and Allen (1953), in his very

extensive study of garden beetles, recorded only two specimens, both taken under cut grass. This species has been recorded from old seed potatoes (e.g. Wood, 1886) but the garden in which the 917 specimens were trapped had not been used for growing potatoes or any other root vegetables for at least a decade and the ground in which the trap was set had received only minimal cultivation for many years. Abroad, *Parabathyscia* forms part of a large group of related genera, many of which live in caves. As far as adaptation to underground existence goes, *P. wollastoni* has long been noted to lack eyes. Examination of about 20 trapped specimens revealed that they lacked wings but the elytra were not fused.

Alevonota aurantiaca. A single specimen of this species was trapped in a garden on loam at what was historically the edge of the North Downs. The species is known only from Dorset, South Hampshire and Surrey, where it has been found on relatively few occasions usually by sweeping in calm weather (Allen, 1991). Two specimens were caught in a flight interception trap on chalk downland (Owen, 1997b). Its appearance in an underground trap supports the view that it essentially an underground species.

Acrotona parens. This species was not recognised as British until Champion (1909) recorded a specimen from Guildford, Surrey. Since then, it has been noted in other parts of south and south-eastern England and in North Wales though there are few published records.

Trichonyx sulcicollis. A single specimen was trapped in a garden backing on to a large woodland area. The beetle has been recorded mostly from woodland areas though the only other example found by the author was also in a garden, at Bishop's Waltham, Hampshire.

Athous campyloides. A male and female of this crepuscular species was trapped in a garden on loam, along with two larvae probably of this species. The beetle is normally found at the roots of grass in sandy areas.

Rhizophagus parallelocollis. Sixteen specimens came from traps in three gardens. The species has long been recognised as one occurring underground, usually in association with the corpses of animals or with coffins. Enquiries, however, did not uncover any other evidence of burials in the gardens concerned. This species has wings and the elytra are not fused. Peacock (1977), citing Horion (1960), states that adults come to the surface in spring and swarm.

Rhizophagus perforatus. This was one of the commonest species to trapped. It is another species recognised as a garden insect (e.g. Henderson, 1945; Allen 1950), being found usually under pieces of wood or stones or in compost. It appears regularly in small numbers in an m.v. light trap set near a compost heap in the author's garden.

Table 1: Beetles taken in underground traps set in gardens.
The total number of specimens was 2240. Data cover 12 gardens.

Species	Number of gardens with species	Number of specimens
CARABIDAE		
Clivina fossor (Linnaeus)	1	1
Trechus obtusus Erichson	1	1
Stomis pumicatus (Panzer)	1	6
HYDROPHILIDAE		
Megasternum obscurum (Marsham)	3	6
HISTERIDAE		
Abraeus globosus (Hoffmann)	1	7
Kissister minimus (Aubé)	1	1
PTILIIDAE		
Ptenidium laevigatum Erichson	2	13
P. pusillum (Gyllenhal)	2	3
LEIODIDAE		
Parabathyscia wollastoni (Janson)	4	950
STAPHYLINIDAE		
Coprophilus striatulus (Fabricius)	1	1
Platystethus nitens (Sahlberg)	1	1
Anotylus sculpturatus (Gravenhorst)	5	53
A. tetracarinatus (Block)	2	5
Lathrobium fulvipenne (Gravenhorst)	1	1
L. multipunctum Gravenhorst	1	1
Sunius propinquus (Brisout)	2	13
Othius myrmecophilus Kiesenwetter	1	2
Xantholinus linearis (Oliver)	2	4
Quedius mesomelinus (Marsham)	1	2
Tachyporus dispar (Paykull)	1	1
T. hypnorum (Fabricius)	1	1
T. nitidulus (Fabricius)	2	3
Tachinus subterraneus (Linnaeus)	1	2
Cordalia obscura (Gravenhorst)	3	3
Callicerus rigidicornis (Erichson)	1	4
Dinaraea angustula (Gyllenhal)	1	1
Plataraea brunnea (Fabricius)	1	9
Philhygra elongatula (Gravenhorst)	1	2
Mocyta fungi (Gravenhorst)	1	1
Acrotona parrens (Mulsant & Rey)	1	1
Datomicra nigra (Kraatz)	1	3
Atheta triangulum (Kraatz)	2	32
A. xanthopus (Thomson)	2	30
A. crassicornis (Fabricius)	2	7
A. oblita (Erichson)	2	11
Alevonota aurantiaca Fauvel	1	1
Oxypoda opaca (Gravenhorst)	1	2

Species	Number of gardens with species	Number of specimens
PSELAPHIDAE		
Euplectus karsteni (Reichenbach)	1	2
Trichonyx sulcicollis (Reichenbach)	1	1
SCARABAEIDAE		
Oxyomus sylvestris (Scopoli)	1	3
ELATERIDAE		
Melanotus villosus Geoffroy	1	1
Athous campyloides Newman	1	2
THROSCIDAE		
Trixagus carinifrons (de Bonvouloir)	1	2
NITIDULIDAE	1	3
Carpophilus marginellus Motschulsky	2	2
Glischrochilus hortensis (Fourcroy)	1	1
RHIZOPHAGIDAE		
Rhizophagus parallelocollis Gyllenhal	3	16
R. perforatus Erichson	9	183
CRYTOPHAGIDAE		
Atomaria testacea (Marsham)	3	3
A. pulchra Erichson	1	1
BOTHRIDERIDAE		
Anommatus diecki Reitter	7	38
A. duodecimstriatus (Müller)	9	285
ENDOMYCHIDAE		
Mycetaea hirta (Marsham)	1	1
LATRIDIIDAE		
Aridius nodifer (Westwood)	2	10
Cortinicara gibbosa (Herbst)	1	1
COLYDIIDAE		
Langelandia anophthalma Aubé	4	162
CHRYSOMELIDAE		
Phyllotreta nigripes (Fabricius)	1	4
CURCULIONIDAE		
Otiorhynchus singularis (Linnaeus)	1	1
Barypeithes araneiformis (Schrank)	3	57
B. pellucidus (Boheman)	8	85
Raymondionymus marqueti (Aub.)	10	193

Anommatus diecki. This species is known to lack eyes and examination of a number of examples showed that it also lacked wings and has fused elytra. Until recently, this species was known only from Cheshire where the first recognised British specimens were found in 1984 (Eccles & Bowestead, 1986). Subsequently, as noted by Booth & Owen (1997), a few specimens taken prior to its discovery in Cheshire were discovered among material in The Natural History Museum, London and specimens have been found recently in gardens in Kent and East Sussex.

Anommatus duodecimstriatus. This was one of the commonest beetles trapped with 285 examples recorded from nine gardens. Another eye-less species, it also lacks wings and has fused elytra. In Britain, it has been found in various localities in the southern half of England, frequently in the shrivelled skins of seed potatoes remaining in the soil after producing the potato plant. It has also been found in decomposing vegetable debris (Allen, 1954), under bark and at tree roots. It occurs regularly in the remains of seed potatoes in a garden allotment situated near some of the gardens studied.

Langelandia anophthalma. There were 162 examples recorded from four gardens but it has yet to be obtained by trapping in woodlands. It is yet another species lacking eyes and wings and with fused elytra. This species was first found in Britain in the remains of seed potatoes at St Peters in Kent (Wood, 1886). Wood recorded that the seed potatoes came from Guernsey and discussed the possibility that the beetle might have been imported. At the time it was noted in Europe to be found principally in gardens under pieces of wood or wooden objects such as barrels lying on the ground. As in the case of the last species, it has been recorded mainly from the remains of seed potatoes but it has also been found in association with old roots. There are published records for sites in southern England stretching from Kent to Cornwall (e.g. Wood, 1886; Allen, 1937; Allen, 1954; Booth, 1977; Denton, 1997). Nearly all of these records have been for essentially synanthropic situations. It is perhaps relevant that many specimens of the beetle were found on the under-surface of large logs lying on the ground in the author's garden in the 18 months immediately preceding the first use in the garden of underground traps.

Barypeithes araneiformis and *B. pellucidus*. These two polyphagous, ground-dwelling weevils were trapped in relatively large numbers. They have eyes but are without wings and have fused elytra. Their occurrence in underground traps indicate that they burrow below the surface possibly for laying eggs in roots.

Raymondionymus marqueti. This is another species which was trapped in some numbers in gardens but not in woodlands. The species is known to lack eyes (Osella, 1977). Examination of a number of specimens trapped in the Epsom area showed that they also lacked wings and have fused elytra. It appears to be an introduced species which was first noted at Kew Gardens, Richmond (Williams, 1968) and later at Bromley, Kent (Thompson, 1995). An account of its presence in north-west Surrey has already been published (Owen, 1997a).

Type number of soil	Number of gardens	Trapping effort (trap-weeks)	Total number of beetles	Number of beetles per trap-week	Average of species per garden
Chalk	4	309	1708	5.8	14.5
Fine sand	1	30	1	–	1
Loam	5	71	206	2.9	7.4
Clay	2	86	325	3.5	17.5

Table 2: Influence of soil type on numbers of beetles and numbers of species trapped in gardens.

Comments on the trapping procedure

In general, the trapping procedure used in thus study has proved simple and reliable, both in the author's hands and in the hands of colleagues. Two traps suffered interference from animals, being torn out of the ground and chewed. This happened once in the author's garden when he forgot to replace a stone covering the mouth of the trap which allowed it to be dug up, presumably by a fox as it would not have been accessible to a dog. On the second occasion, the trap dug up was in a wood accessible to dogs and foxes. It had been covered with a stone but, presumably, this was not sufficiently heavy.

Although no trouble has been experienced in lifting up traps and re-siting them, two minor modifications make the trap stronger. Firstly, the mouth of the trap can be strengthened by setting a short (1cm) section of rigid pipe into the upper end of the netting cylinder, fixing this in place with a rim of "Blue Tac" adhesive (Bostik Ltd, Leicester) and winding PVC self-adhesive tape round the outside. Secondly, by means of a curved needle, a length of fine, plastic covered wire can be threaded vertically through both layers of netting where they overlap to help maintain its cylindrical shape. "Netlon" greenhouse shading (Netlon Ltd., Blackburn) has proved a satisfactory alternative to nylon mesh but traps longer than 20cm made with "Netlon" mesh require a short (1cm) section of rigid pipe set inside half-way down, and fixed as for the strengthened rim, to maintain the netting in a cylindrical shape.

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